

Body Mass Index and Chronic Energy Deficiency among the Adult Oraons of Sambalpur, Odisha

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Abstract

Background: Nutritional problems among tribal communities may occur in the form of both undernutrition and excess body weight. However, information on the nutritional status of adult Oraons in Odisha is limited. The present study was undertaken to assess BMI and the prevalence of chronic energy deficiency (CED) among adult Oraons of Sambalpur district, Odisha.

Materials and Methods: A community-based cross-sectional study was conducted among 783 Oraon subjects aged 20 years and above from selected settlements of Dhankauda and Rengali areas of Sambalpur district. The study included 381 males and 402 females. Height and weight were measured using standard anthropometric procedures, and BMI was calculated from the recorded measurements. Nutritional status was assessed by classifying the subjects into CED-I, CED-II, CED-III, normal, overweight and obesity categories.

Results: CED was observed in 24.5% of the studied subjects, with a similar proportion among males (24.1%) and females (24.9%). CED-I was the most frequently observed category (12.5%), followed by CED-II (6.3%) and CED-III (5.7%). Nearly half of the subjects (49.3%) had a normal BMI, while 18.5% were overweight. Obesity was observed in 7.7% of the subjects, including 6.9% with Class-I and 0.8% with Class-II obesity.

Conclusion: The study shows that both undernutrition and excess body weight were present among the adult Oraons of Sambalpur. While nearly one-fourth of the subjects had CED, a substantial proportion was also overweight or obese, indicating a dual burden of malnutrition in the studied population.

Keywords: Body mass index, chronic energy deficiency, nutritional status, Oraon, Odisha.

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I. Introduction

India is home to a large number of tribal communities, making the study of their health and nutritional conditions particularly important. Earlier studies have reported considerable differences in nutritional status among tribal groups living in different parts of the country (Topal and Samal, 2001; Arlappa et al., 2005). The nutritional condition of tribal populations is influenced by several factors, including availability of food, household economic conditions, physical workload, dietary practices, and access to healthcare. Therefore, assessment of nutritional status at the community level is important for understanding the health conditions of these populations.

Anthropometric measurements provide a simple and practical approach for assessing the nutritional and health status of adults. The World Health Organization has recognized anthropometry as an important method for evaluating nutritional status and monitoring health conditions at the population level (WHO, 1995). Among the various anthropometric measures, body mass index (BMI), calculated as body weight in kilograms divided by height in metres squared, is one of the most commonly used indicators of adult nutritional status (Keys et al., 1972). The index is commonly referred to as Quetelet's index and is associated with the work of the nineteenth-century mathematician Lambert Adolphe Jacques Quetelet (Quetelet, 1842). BMI has been widely used as an indicator of relative body weight and adiposity because it is simple to measure and suitable for population-based studies (Khosla and Lowe, 1967; Garrow and Webster, 1985; Smalley et al., 1990; Deurenberg et al., 1991; Strain and Zumoff, 1991).

BMI is particularly useful in community-based studies because it requires only basic measurements of height and weight and can be applied to large groups at relatively low cost (Lohman et al., 1988; Ferro-Luzzi et al., 1992; James et al., 1994; Lee and Nieman, 2003). In addition to providing information on nutritional status, BMI has also been associated with socioeconomic and living conditions, particularly in developing-country

populations (Ferro-Luzzi et al., 1992; Shetty and James, 1994; Nube et al., 1998; Khongsdier, 2002; Mosha, 2003). A BMI below 18.5 kg/m² is commonly used to identify chronic energy deficiency (CED) among adults. Persistent low body weight may be associated with inadequate energy intake, high physical activity, recurrent infections, and other conditions that affect nutritional well-being (James et al., 1988; Shetty and James, 1994; WHO, 1995).

Chronic energy deficiency can have important consequences for an individual's health and daily functioning. Prolonged inadequate energy availability may reduce physical work capacity and productivity and may increase susceptibility to illness through impaired immune function (Pryer, 1993; Durnin, 1994; Kennedy and Garcia, 1994; Garcia and Kennedy, 1994; Strickland and Ulijaszek, 1994). Nutritional status is particularly important among women of reproductive age. Maternal undernutrition has been associated with adverse birth outcomes, including low birth weight, which is an important indicator of maternal health and the survival and subsequent growth of the newborn (Gopalan, 1996; WHO, 1984). Studies from developing countries have also reported inadequate body weight and dietary energy intake among women, particularly where physical workloads are high (Samuel and Rao, 1992; Kisanga, 1990).

Although a number of studies have examined the nutritional status of tribal communities in India, information remains limited for several tribal populations and geographical regions (Arlappa et al., 2005; Bose and Chakraborty, 2005; Bose et al., 2006a, b, c, d; Ghosh and Bala, 2006). Studies conducted among different tribal groups have demonstrated substantial variation in anthropometric characteristics and the prevalence of undernutrition. These variations indicate the importance of examining individual tribal communities within their specific ecological, socioeconomic, and cultural settings. Bose and Chakraborty (2005) also emphasized the need for further assessment of the nutritional status of different tribal populations in India.

Against this background, the present study was undertaken to assess the nutritional status of adult Oraons of Sambalpur, Odisha, using body mass index. The study also provides an opportunity to understand the anthropometric profile of the Oraon population and to compare its nutritional status with findings reported among other tribal populations of India.

II. Material and methods

The present study was conducted using a community-based cross-sectional research design to assess body mass index (BMI) and chronic energy deficiency among adult Oraons of Sambalpur district, Odisha. The study was carried out from June 2022 to October 2025 in selected Oraon-dominated settlements of Dhankauda and Rengali areas of the district. A total of 12 padas were included in the study, comprising Maharupada, Pinguapada, Litapada, Chhapalpada, Jotupada, Dalipada, Baghapada, Motiyapada and Champapada under Dhankauda, and Baradungri, Kuda Munda and Baghiya under Rengali. The study included Oraon subjects aged 20 years and above residing in the selected areas. Pregnant and lactating women and individuals with physical deformities that could interfere with anthropometric measurements were excluded.

A total of 783 studied subjects, comprising 381 males and 402 females, were included in the study. The sample size was initially estimated using Cochran's formula and was subsequently increased to ensure adequate representation of the study population. The subjects were selected using a random sampling method. Anthropometric measurements were recorded following standard procedures. Body weight was measured in kilograms using a calibrated weighing scale, while height was measured in centimetres using an anthropometric rod. Measurements were taken with the subjects barefoot and wearing light clothing. BMI was calculated by dividing body weight in kilograms by the square of height in metres (kg/m²).

The nutritional status of the studied subjects was assessed based on BMI. Subjects with a BMI below 18.50 kg/m² were classified as underweight and further categorised as mild CED (CED-I: 17.00–18.49 kg/m²), moderate CED (CED-II: 16.00–16.99 kg/m²) and severe CED (CED-III: <16.00 kg/m²). A BMI of 18.50–24.99 kg/m² was considered normal, 25.00–29.99 kg/m² as overweight, and BMI ≥30.00 kg/m² as obesity, with obesity further classified into Class-I, Class-II and Class-III. The corresponding risk of co-morbidities was considered according to the BMI classification used in the study.

Classification	Range	Risk of Co-morbidities
Underweight (severe)CED-III	<16.00	Very High
Underweight (moderate)CED-II	16.00 – 16.99	High
Underweight (Mild) CED-I	17.00 – 18.49	Moderate
Normal	18.50 – 24.99	Average
Overweight (pre-obese)	25.00 – 29.99	Increased
Obese (Class-I)	30.00 – 34.99	Moderate
Obese (Class-II)	35.00 – 39.99	Severe
Obese (Class-III)	≥40	Very Severe

(source: WHO 1995)

The collected data were entered and analysed using SPSS. Frequency and percentage were used to describe the distribution of BMI categories, while median and interquartile range were used for continuous variables as the data was not normally distributed.

Ethical approval

Ethical approval was obtained from the Institutional Ethics Committee of Gangadhar Meher University, Sambalpur, Odisha (Ref. No. 9866). Permission was also obtained from the concerned community, and informed consent was obtained from all studied subjects before data collection.

III. Result

Table 1: Sex specific age and anthropometrics difference

Somatometric measurements	Male (381)		Female (402)	
	Median	IQR	Median	IQR
Age	45	(32 - 54)	42	(31-55)
Height	154.5	(150.0-158.7)	151.5	(147.7-155.5)
Weight	50.3	(43.0-60.3)	50.0	(41.8-59.5)
BMI	20.77	(18.56 – 25.13)	21.73	(18.49-25.73)

The table 1: illustrates the median and interquartile range (IQR) of selected somatometric measurements among male and female studied subjects. The median age was 45 years among males and 42 years among females, showing a relatively similar age distribution in both groups. Males had a higher median height (154.5 cm) compared with females (151.5 cm). However, the median weight was almost similar among males (50.3 kg) and females (50.0 kg). The median BMI was slightly higher among females (21.73 kg/m²) than males (20.77 kg/m²). Overall, males were taller, while body weight was nearly comparable between the sexes and females showed a slightly higher median BMI.

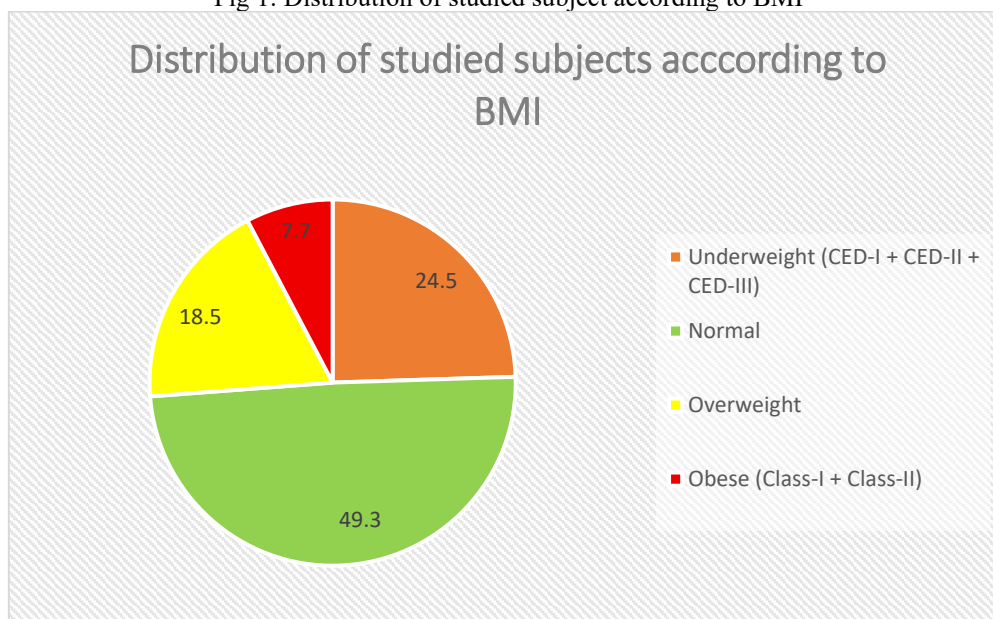
Table 2: Sex specific Nutritional status of adult Oraon subjects by BMI

Nutritional status	Male (N=381)		Female (N=402)		Sex combined (N=783)	
	N	%	N	%	N	%
CED-III	17	4.5	28	7.0	45	5.7
CED-II	28	7.3	21	5.2	49	6.3
CED-I	47	12.3	51	12.7	98	12.5
Total CED	92	24.1	100	24.9	192	24.5
Normal	191	50.1	195	48.5	386	49.3
Overweight	69	18.1	76	18.9	145	18.5
Obese (Class-I)	26	6.8	28	7.0	54	6.9
Obese (Class-II)	03	0.8	03	0.7	06	0.8

Table 2: illustrates the nutritional status of the studied subjects according to sex. Nearly one-fourth (24.5%) of the studied subjects were affected by CED, with a slightly higher proportion among females (24.9%) than males (24.1%). Among the different grades of CED, CED-I was the most commonly observed (12.5%), followed by CED-II (6.3%) and CED-III (5.7%). CED-III was more common among females (7.0%) than males (4.5%), whereas CED-II was slightly higher among males (7.3%) than females (5.2%).

About half of the studied subjects (49.3%) had normal nutritional status. The proportion was slightly higher among males (50.1%) than females (48.5%). Overweight was observed in 18.5% of the subjects, with a slightly higher proportion among females (18.9%) compared to males (18.1%). Obesity was less frequent, with 6.9% of the subjects classified as obese Class-I and 0.8% as obese Class-II. Overall, the findings show that while normal nutritional status was observed in about half of the studied subjects, CED was also relatively common, along with a smaller but notable proportion of overweight and obesity.

Fig 1: Distribution of studied subject according to BMI



IV. Discussion

Table 3: comparison of Male body Height and Weight from previous studies of Odisha

Sl No	Author	Year	Tribe	Male	Height	SD	Weight	SD
1.	Goswami M.	2010	Bhumija	66	163.44	7.24	50.68	7.85
2.	Goswami M.	2012	Bhuyan	303	159.5	6.97	46.5	7.65
3.	Goswami M.	2015	Mankidias	124	158.4	5.84	48.5	3.87
4.	Sahoo et al.	2024	Paudi Bhuyan	211	157.0	5.80	48.0	7.61
5.	Present study	2026	Oraons	381	154.83	6.65	52.69	11.30

Table 3 : shows that the male Oraons in the present study had a mean height of 154.83 ± 6.65 cm and a mean weight of 52.69 ± 11.30 kg. Compared with the tribal groups reported in earlier studies, the Oraon males were shorter in stature than the Bhumija (163.44 ± 7.24 cm), Bhuyan (159.50 ± 6.97 cm), Mankidia (158.40 ± 5.84 cm), and Paudi Bhuyan (157.00 ± 5.80 cm). Thus, the present study recorded the lowest mean height among the groups included in the comparison.

In terms of body weight, the Oraon males had a higher mean weight than the Bhuyan (46.50 ± 7.65 kg), Mankidia (48.50 ± 3.87 kg), and Paudi Bhuyan (48.00 ± 7.61 kg), but lower than the Bhumija males (50.68 ± 7.85 kg). The relatively higher mean weight among the Oraon males, despite their shorter stature, indicates variation in body composition and nutritional status across the tribal groups.

Table 4: comparison of Female body Height and Weight from previous studies of Odisha

Sl No	Author	Year	Tribe	Female	Height	SD	Weight	SD
1.	Goswami M.	2010	Bhumija	73	150.26	3.93	41.86	5.01
2.	Goswami M.	2012	Bhuyan	324	154.02	7.01	40.2	6.31
3.	Goswami M.	2015	Mankidias	136	148.1	6.04	40.8	4.63
4.	Sahoo et al.	2024	Paudi Bhuyan	310	147.0	5.36	41.0	6.77
5.	Present study	2026	Oraons	402	151.31	6.40	51.40	12.08

Table 4: shows the mean body height and weight of females among different ethnic groups. The result of the present study revealed that the mean height of Oraon females was 151.31 ± 6.40 cm. The Oraon females presented a taller mean height than the Bhumija (150.26 ± 3.93 cm), Mankidia (148.1 ± 6.04 cm), and Paudi Bhuyan (147.0 ± 5.36 cm) females. However, the mean height of Oraon females was lower than that reported among Bhuyan females (154.02 ± 7.01 cm). Among the compared populations, the greatest mean height was observed among Bhuyan females, whereas the lowest was recorded among Paudi Bhuyan females.

The mean body weight of Oraon females in the present study was 51.40 ± 12.08 kg, which was higher than the mean body weight reported among all the other tribal populations included in the comparison. The mean body weight was 41.86 ± 5.01 kg among Bhumija females, 40.2 ± 6.31 kg among Bhuyan females, 40.8 ± 4.63 kg among Mankidia females, and 41.0 ± 6.77 kg among Paudi Bhuyan females. Thus, the present study recorded

comparatively higher mean body weight among Oraon females. The differences observed in body height and weight may be influenced by variations in nutritional status, dietary practices, physical activity, socioeconomic conditions, geographical setting, and age composition of the studied populations.

Table 5: Comparison of BMI from previous studies

Sl No	Author	Year	Tribe	Male	Mean $\pm$ SD	Female	Mean $\pm$ SD
1.	Goswami M.	2010	Bhumija	66	18.9 $\pm$ 2.41	73	18.4 $\pm$ 1.87
2.	Goswami M.	2012	Bhuyan	303	18.2 $\pm$ 2.71	324	17.0 $\pm$ 2.98
3.	Goswami M.	2015	Mankidias	124	19.3 $\pm$ 2.15	136	18.6 $\pm$ 2.81
4.	Kshatriya G. K	2016	Santal	121	19.6 $\pm$ 2.5	119	18.1 $\pm$ 2.8
5.	Kshatriya G. K	2016	Bhumij	116	20.2 $\pm$ 2.8	122	20.3 $\pm$ 3.0
6.	Kshatriya G. K	2016	Bathudi	119	19.5 $\pm$ 2.8	121	18.0 $\pm$ 2.8
7.	Kshatriya G. K	2016	Dhodia	121	20.5 $\pm$ 3.2	120	20.7 $\pm$ 3.5
8.	Sahoo et al.	2024	Paudi Bhuyan	211	20.0 $\pm$ 2.73	310	19.0 $\pm$ 2.87
9.	Present study	2026	Oraons	381	21.9 $\pm$ 4.60	402	22.4 $\pm$ 4.95

Table 5: shows the mean BMI of males and females among different tribal populations. The present study revealed that the mean BMI of Oraon males was 21.9 $\pm$ 4.60 kg/m², while that of Oraon females was 22.4 $\pm$ 4.95 kg/m². The mean BMI of Oraon males was higher than that reported among Bhumija (18.9 $\pm$ 2.41 kg/m²), Bhuyan (18.2 $\pm$ 2.71 kg/m²), Mankidias (19.3 $\pm$ 2.15 kg/m²), Santal (19.6 $\pm$ 2.5 kg/m²), Bhumij (20.2 $\pm$ 2.8 kg/m²), Bathudi (19.5 $\pm$ 2.8 kg/m²), Dhodia (20.5 $\pm$ 3.2 kg/m²), and Paudi Bhuyan (20.0 $\pm$ 2.73 kg/m²) males. Similarly, the mean BMI of Oraon females was higher than that reported among Bhumija (18.4 $\pm$ 1.87 kg/m²), Bhuyan (17.0 $\pm$ 2.98 kg/m²), Mankidias (18.6 $\pm$ 2.81 kg/m²), Santal (18.1 $\pm$ 2.8 kg/m²), Bhumij (20.3 $\pm$ 3.0 kg/m²), Bathudi (18.0 $\pm$ 2.8 kg/m²), Dhodia (20.7 $\pm$ 3.5 kg/m²), and Paudi Bhuyan (19.0 $\pm$ 2.87 kg/m²) females.

Among the compared populations, the highest mean BMI was observed among Oraon females (22.4 $\pm$ 4.95 kg/m²), followed by Oraon males (21.9 $\pm$ 4.60 kg/m²). The lowest mean BMI was recorded among Bhuyan females (17.0 $\pm$ 2.98 kg/m²). Overall, the present study indicates comparatively higher mean BMI among both Oraon males and females than the other tribal populations included in the comparison. The relatively higher BMI observed among the Oraons may reflect differences in dietary practices, nutritional status, lifestyle, physical activity, socioeconomic conditions, and other population-specific factors.

Table 6: Proportional differences of prevalence of Underweight from previous studies

Sl No	Author	Year	Tribe	Male	%	Female	%
1.	Goswami M.	2010	Bhumija	66	48.5	73	54.8
2.	Goswami M.	2012	Bhuyan	303	58.7	324	77.7
3.	Goswami M.	2015	Mankidias	124	48.4	136	59.5
4.	Dehury B.	2015	Munda	35	78.57	16	62.5
5.	Kshatriya G. K	2016	Santal	121	28.1	119	31.1
6.	Kshatriya G. K	2016	Bhumij	116	19.0	122	37.0
7.	Kshatriya G. K	2016	Bathudi	119	39.5	121	62.8
8.	Kshatriya G. K	2016	Dhodia	121	28.1	120	29.2
9.	Dash N. C.	2017	Lodha	319	54.5	319	49.2
10.	Kanrar P.	2020	Juang	414	51.9	423	62.9
11.	Mahanty B.	2022	Bondo	266	32.0	247	39.3
12.	Sahoo et al.	2024	Paudi Bhuyan	211	35.07	310	48.71
13.	Present study	2026	Oraon	381	24.9	402	24.9

Table 6: shows the proportion of males was highest among the Munda (78.57%), followed by the Bhuyan (58.7%), Lodha (54.5%), Juang (51.9%), Bhumija (48.5%), and Mankidia (48.4%). In contrast, the lowest proportion of males was reported among the Bhumij (19.0%), followed by the Oraon (24.9%) in the present study and Dhodia (28.1%) and Santal (28.1%). Among females, the highest proportion was observed among the Bhuyan (77.7%), followed by Juang (62.9%), Bathudi (62.8%), Munda (62.5%), and Mankidia (59.5%). The lowest proportion of females was reported among the Oraons (24.9%), followed by the Santal (31.1%) and Dhodia (29.2%).

V. Conclusion

Compared with previous studies on anthropometric indices among different tribal populations in the country, the Oraon males and females in the present study showed comparatively greater mean height and body weight, along with higher mean BMI. The mean BMI was 21.9 $\pm$ 4.60 kg/m² among males and 22.4 $\pm$ 4.95 kg/m² among females, indicating a relatively improved nutritional profile compared with several of the populations reported in earlier studies. However, the findings also indicate the coexistence of undernutrition with increasing overweight and obesity, suggesting that nutritional problems among the Oraons are not limited to a single form of malnutrition.

The observed differences in anthropometric characteristics may be related to variations in food availability, dietary practices, livelihood patterns, physical workload, socioeconomic conditions, and access to healthcare. The comparatively higher body weight and BMI observed among Oraon females may also reflect changes in lifestyle and nutritional patterns. Overall, the Oraon population shows considerable variation in nutritional status, with both undernutrition and emerging overnutrition requiring attention. The findings highlight the need for appropriate community-based and region-specific nutrition and health interventions, along with health education and regular nutritional assessment, to address the changing nutritional needs of the Oraon community.

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